TECHNOLOGICAL CHANGE AND PRODUCTIVITY ANALYSIS IN NEBRASKA

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Introduction

Productivity growth has been an important source of US economic growth throughout the century

The years since 1940 have been an even faster growth in agricultural productivity (Ball, et.al. 1998; Tokgöz, 2002).

Several factors have been identified as the most important sources of productivity change in US agriculture.

Chandler (1962) attributes over 75 percent of the growth in productivity to technological factors in the post war years.

In Nebraska, several productivity studies conducted that include (Perrin et al, 2001; ball et al, 2001; and Palestina et al(2009).

None of the studies disaggregate land into poor and good lands and measures their relationships.

As producers respond to higher crop prices, marginal/poor lands will be converted into cropland.

To be able to estimate the indirect effect on land use, one needs to know own and cross price elasticities for the different land types.

Objectives

- Estimate economies of scale and rate of technological progress for the period covering, 1960-2004 in Nebraska
- Estimate own and cross elasticities for the different land types
- Estimate rate of substitution between agricultural inputs in Nebraska

Analytical Approach

Translog Cost Function

$$\ln C = \alpha_0 + \sum_1^n \alpha_i \ln W_i + 1/2 \sum_1^n \sum_1^n \beta_{ij} \ln W_i \ln W_j + \alpha_Y \ln Y_i + 1/2 \beta_{YY} (\ln Y_i)^2 + \sum_i^n \gamma_{Yi} \ln W_i \ln Y_i + \phi_T t + 1/2 \phi_{TT} t^2 + \sum_1^n \phi_{Ti} t. \ln W_i + \sum_1^n \phi_{TY} t. \ln Wi$$

Homogeneity: $\sum_i \alpha_i = 1; \quad \sum_i \beta_{ij} = \sum_j \beta_{ji} = \sum_i \gamma_{Yi} = \sum_{i\gamma} \phi_{Ti} = 0$

Symmetry condition: $\beta_{ij} = \beta_{ji}$ for all i, j is assumed.

$$\frac{\partial \ln C}{\partial \ln P_i} = \frac{X_i P}{C} = S_i = \beta_i + \sum_j \beta_{ij} \log P_j + \beta_{Qi} \log Q + \beta_{ti} \log t$$

The elasticity of scale, which measures relative changes in output resulting from proportional changes in all inputs, is described by Hanoch in relation to the total cost and output along the expansion path. It can be obtained from the Translog cost function as

$$\varepsilon = \frac{1}{\partial \ln C / \partial \ln Q} = (\alpha_Q + \gamma_{QQ} \ln Q + \sum_i \gamma_{Qi} \ln P_i + \Phi_{TQ} t)^{-1}$$

Following Baumol, Panzar, and Willig(1982), scale economies in a multiple-output case is estimated as:

$$\varepsilon = \frac{C}{\sum_i Q_i MC_i} = \frac{1}{\sum_i \partial \ln C / \partial \ln Q_i}$$

Rate of technical progress (λ_t) is given by

$$\lambda(t) = -\frac{\log C}{t} = \frac{1}{t}\left[\beta_t + \beta_{tt} \log t + \beta_{Yt\log} Y + \sum_j \beta_{ti} \log W_i\right]$$

Technological progress has a factor i using bias if $\beta_{ti} \succ 0$. It is neutral with respect to factor i if $\beta_{ti} = 0$ and it is a factor i saving if $\beta_{ti} \prec 0$.

Results

Tables 1: Restricted Iterated SUR Estimates of the Translog Cost Function, 1960-2004

Variables	SH1(labor)	SH2(Land)	SH3(Capital)
	Coeff	Coeff	Coeff
lnW1(land) fixed input	0.1135*** (0.0188)	-0.0114 (0.0166)	-0.1467*** (0.01139)
lnW2(labor)	-0.0855*** (0.0029)	0.1895*** (0.0025)	-0.0587*** (0.0017)
lnW3(capital)	-0.0769*** (0.0044)	-0.0529*** (0.0039)	0.1727*** (0.0027)
lnW4(Int. Inputs)	-0.0441*** (0.0034)	-0.0476*** (0.0030)	-0.0344*** (0.0021)
lnY1(Feed crops)	-0.0042 (0.0033)	0.0058** (0.0029)	-0.0044** (0.0020)
lnY2(Oil Crops)	0.0052 (0.0037)	-0.0060* (0.0032)	0.0038*** (0.0022)
lnY3(Beef)	0.0342*** (0.0069)	-0.0353*** (0.0061)	0.0245*** (0.0042)
Time	-0.0004*** (0.0001)	0.0028*** (0.0001)	-0.0002*** (0.0001)
Constant	1.1794*** (0.1788)	-0.4200*** (0.1576)	0.8027*** (0.1081)

*Coefficients are bolded if statistically significant

Table 2: Estimated Allen Partial Elasticities of Substitution (σ_{ij})

	Labor	Land	Capital	Inter. Inputs
Labor	-0.15884932			
Land	0.14295868	-0.09757624		
Capital	-0.03653315	0.00904878	-0.05271951	
Int. Inputs	-0.02177090	0.00849625	0.01429695	0.00790244

Conclusion

Preliminary analysis of the result suggests that, given the inputs used for the study, there is an increasing economies of scale in the entire period, though in a decreasing rate.

The rate of technological progress was increasing for the period covering 1960 to 1971.

The technology going to the production of feed crops and oil crop production have been labor and intermediate inputs saving and capital consuming.

Substitution possibilities and complementarities between the inputs are also observed.